DISCUSSION

PARKER, USA

I would like to comment on the results Dr. Benson presented with respect to subjects' variability in the response to straight line motion by showing data we have been able to obtain from other missions.

THRESHOLDS FOR DETECTION OF LINEAR OSCILLATION FOLLOWING PROLONGED WEIGHTLESSNESS

D.E. Parker*, M.F. Reschke**, A.P. Arrott***,
J.L. Homick**, B.K. Lichtenberg***

* Department of Psychology, Miami University, Oxford, OH 45056
** Space Biomedical Research Institute, NASA-Johnson Space Center (SB), Houston TX 77058
*** Payload Systems Inc. P.O. Box 38, Babson Park, Wellesley, MA 02157

INTRODUCTION

Dr. Benson has reported that linear self-motion detection thresholds, which were recorded as part of the European Vestibular Experiments, varied across subjects. This varibility is consistent with observations following the STS-8 and STS-11 Shuttle missions.

METHOD

Three astronauts who participated in the STS-8 and STS-11 (41-B) missions served as subjects in this experiment.

The apparatus employed was the Miami University Parallel swing. This apparatus is described in Paper No. 3--REINTERPRETATION OF OTOLITH INPUT AS A PRIMARY FACTOR IN SPACE MOTION SICKNESS.

Nominal amplitudes of parallel swing motion were determined by recording the displacement of a pointer attached to the swing bed relative to a scale taped to the floor. These nominal amplitudes were compared with those determined with a three-axis accelerometer and strip-chart recorder.

The subject indicated his perception of self-motion ("yes" or "no") by manipulations of a joystick that was connected to one channel of the strip-chart recorder.

A small signal lamp was mounted on an ear-pad support and was controlled by the experimenter's hand-held microswitch.

The procedure used to determine self-motion thresholds was similar to that used in tracking audiometry. The swing was set in motion at a relatively high amplitude (about 20 cm/sec/sec). In response to a signal from the experimenter, the subject reported whether or not he perceived that he was moving. When his report was affirmative, the swing was stopped and then set in motion at an amplitude 5 cm/sec/sec smaller. Conversely, if the subject failed to detect motion, the swing amplitude was increased on the subsequent trial. The direction of stimulus amplitude change (increasing or decreasing) was altered after two affirmative or negative responses from the subject. Threshold tracking was continued until ten stimulus amplitude direction reversals had been completed or seven minutes had elasped.

The experimenter controlled the swing motion manually. She/he slowly increased the amplitude of swing motion until the desired level was reached. After one or two oscillations at the desired level, the subject was requested to report his self-motion perception.

RESULTS

The results of these observations are illustrated in Figs. 1-4. The data from Astronaut 1 suggest a nearly three-fold elevation of the self-motion detection threshold. Virtually no threshold change was seen with Astronauts 2 and 3.

DISCUSSION

Prolonged weightlessness appeared to produce elevated self-motion detection thresholds in one astronaut. However, a similar threshold elevation was not obtained from the other two astronauts. The basis for this discrepancy is unknown but it may be related to altered detection threshold criteria on the part of the astronaut who exhibited the threshold change.

Failure to record threshold changes following prolonged weightlessness is consistent with our otolith tilt-translation reinterpretation hypothesis. This hypothesis suggests that the sensitivity of the otolith receptors is not altered by weightlessness; rather the way in which the brain interprets otolith information is changed.

Our procedure required the subjects to report ANY motion. The subject was not required to distinguish between linear motion and tilt. Consequently, the presence in the central nervous system of any "above-the-noise" signal from the otolith receptors would result in a motion report by the subject.

The otolith tilt-translation reinterpretation hypothesis would predict improvement in performance on a task that requires the subjects to detect and respond to linear motion. This predicition derives from the postulate that following prolonged weightlessness, all otolith output is interpreted by the brain as indicating linear motion. Professor Young's report that performance improved on the "otolith closed loop nulling task" supports this predicition.

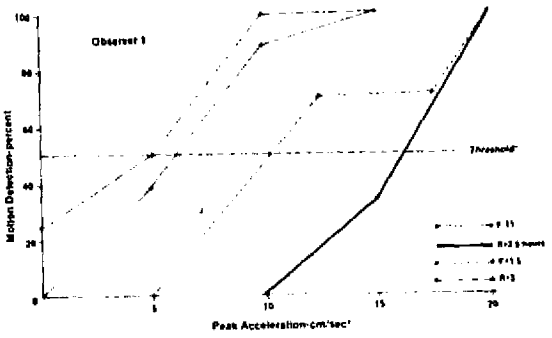

Fig. 1. Thresholds for detection of whole-body, Y-axis linear oscillation from Astronaut 1. The ordinate indicates percent detection and abscissa values are peak half-amplitude of the stimulus. The R+0 data were obtained 2.5 hours after landing.

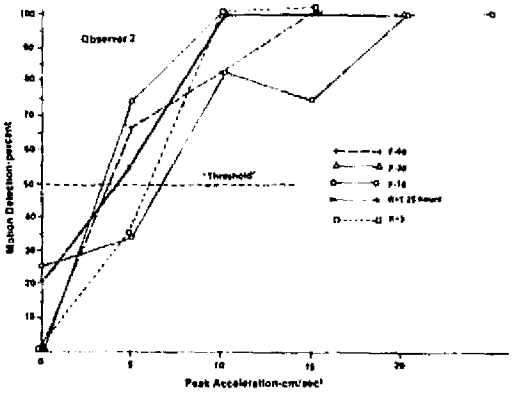

Fig. 2. Thresholds for detection of linear oscillation for Astronaut 2. The R+0 data were obtained 75 minutes after landing.

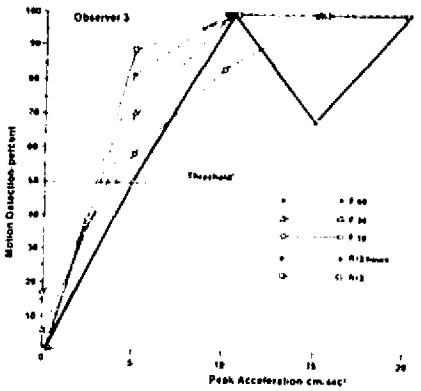

Fig. 3. Thresholds for detection of linear oscillation for Astronaut 3. The R+0 data were obtained 2 hours after landing.

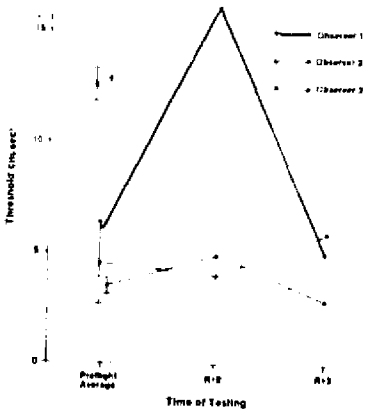

Fig. 4. Summary of thresholds for detection of linear oscillation recorded from Astronauts 1,2, and 3.

AUTHOR'S reply
Thank you, Don. I think your comment was adequately explained by yourself.

KLEIN, FRG
When you pointed out the differences between the red and blue crew I wondered what influence on the results the time of day might have had, since the one group was on day shift, the other one on night shift.

AUTHOR'S reply
We do not know the answer to that, although in the work we have done in the laboratory there do not appear to be large circadian variations in the threshold we are talking about. I think it is much more likely that these effects are either an individual difference or a reflection of the other stimulation that they have been given.

MERBOLD, ESA
I think the threshold is one of these measurements which might be influenced by fatigue. I should mention that the Body Restrained System (BRS) - maybe because it gave us some back pressure - put us asleep more or less immediately. And the same is also true if you sit on that machine on the ground; it is a comfortable rocker-chair and makes you sleepy. I do not know what we can do to avoid that problem.

AUTHOR'S reply
Well, there are a number of things we could do to keep you awake. We are looking at a different psycho-physical proceduring which would take care of people going to sleep.

(SPEAKER unidentified)
A comment regarding the pulsatile pump. If you change temperature in space, you still have that basic pulsatile flow in the same direction. Would that not mask any thermal effects you had? In other words, can you rule the pulsatile pump out, because you do get the increase?

AUTHOR'S reply
No experiments to my knowledge have been done on the characteristics of the pulsatile pulse in terms of producing or modifying responses. The experiment that should be done is using the same stimulus but in different head positions in 1 g. That would be much more critical.

(SPEAKER unidentified)
Was the same testing used pre-flight?

AUTHOR'S reply
Basically the same system was used for pre-flight, in-flight and post-flight tests.